Remarks

Rejection of claims 4-9 and 13-19 under 35 USC §112, first paragraph

Claims 4-9 and 13-19 were rejected under 35 USC §112, first paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter that Applicant regards as the invention. Specifically, claims 4, 7, 13, and 16 are indefinite for reciting the limitation "steps b through e", where no step "e" is recited in claim 1.

Applicant thanks the Examiner for pointing out these typographical errors. In response, claims 4, 7, 13 and 16 have been amended to more appropriately refer to "*steps b through d*", thereby removing this ground for rejection.

Rejection of Claims 23-25, 27-28 and 31-33 under 35 USC §102(b)

Claims 23-25, 27-28 and 31-33 were rejected under 35 USC §102(b) as anticipated by Kumar[1].

More specifically, the Action asserts that all the limitations recited in claim 23 are disclosed by Kumar. Applicant respectfully disagrees. Kumar fails to teach or suggest "*a source for producing a gas cluster ion beam*" as recited in claim 23, and thus present in each of claims 24-34.

The Action asserts that "Kumar *et al.* disclose, in figs 1-30D, an ionized metal cluster ion beam system. The system includes an ion source 20 for producing a gas cluster ion beam; ...." Applicant respectfully suggests this is a misreading of Kumar. Kumar discloses only "wet etching techniques..."[2] and single-ion ion beams[3] for etching purposes. Kumar's liquid metal cluster ion process for metal bump deposition is very different from the gas cluster ion beam (GCIB) of the presently claimed invention. The instant application discloses forming a GCIB by admitting a source gas under pressure into a stagnation chamber and ejecting the admitted gas

[1] U.S. Patent No. 5,331,172 issued July 19, 1994 to Kumar, *et al.*

[2] Kumar, Abstract

[3] Kumar, col. 11, ll. 4-8

into a vacuum through a nozzle to produce a supersonic jet that expands and cools to form clusters of several to several thousands of gas molecules[4]. These clusters are subsequently skimmed and then ionized in an electron impact ionizer and finally accelerated and focused to form a beam. The GCIB of the present invention can be used to etch, clean or smooth surfaces or to form thin films (in the case of reactive gas source materials.)[5] A GCIB, by definition, consists of clusters formed from materials that are normally gasses, such as condensable gases 112 taught in the instant specification to include CO_2, O_2, N_2, and Ar[6]. Metals cannot be transformed into GCIB's.

Kumar's method for creating ionized metal cluster beams is very different than that used to form GCIB's as recited in the instant claims. Kumar discloses the use of a needle or capillary tube source for producing ionized metal clusters and directing such clusters against a surface to deposit metal bumps. Kumar provides a specific example, wherein a sharp 380 _m tungsten needle with groves is plated with metallic gold[7], and elsewhere discloses that a tin-lead alloy may be used as the source material. The needle is resistively heated to melt the gold and a 10 kV electric extraction field is used to pull ionized clusters from the molten gold at the tip of the needle by field emission. These molten gold clusters are directed at a surface where they impinge and deposit a metal layer or "bump"[8]. Alternatively a capillary tube can replace the needle[9], but the Kumar's processes both heat the capillary tube to melt the gold and draw the gold in molten gold clusters from the end of the capillary by field emission in a strong electric field. In both cases, the field emission process ionizes some of the liquid metal clusters. According to Kumar, by varying the electric extraction field strength it is possible to control such a source so that it selectively produces a liquid metal cluster ion beam or a conventional ion

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[4] Instant specification, par. 0030 -0031

[5] Instant specification, par. 0012

[6] Instant specification, par. 0030; Fig. 3, items 112, 308

[7] Kumar, col. 5, ll. 3-15

[8] Kumar, col. 5, ll. 6-15

[9] Kumar, col. 4, ll. 36-42

beam of gold atoms[10]. When the beam from such a source is produces clusters and is directed at a surface, it produces a metal deposition or plating of the surface. Such a liquid metal cluster ion beam is not suitable for etching or cleaning, as is the GCIB of the presently claimed invention. In fact, Kumar teaches that the deposition of metal can cause a source operational problem that must be cured by switching the source to a conventional single ion production mode, which does not produce liquid metal cluster ions, in order to etch away the undesired metal plating[11]. Thus, Kumar clearly teaches that liquid metal cluster ion beams are for metal deposition[12], not for etching as the GCIB's of the presently claimed invention are used. Kumar's sources, ion beams, and methods of producing said beams are very different from the GCIB's of the presently claimed invention, and they also produce different and often opposite surface processing results than the results of GCIB processing.

As stated above, Kumar is devoid of any teaching of a "*source for producing a gas cluster ion beam.*" Kumar discloses liquid metal and conventional metal ion sources, both of which are entirely different from GCIB sources as described in the instant specification. Kumar teaches away from cluster ion etching, teaching instead that conventional ions should be used for etching. And as indicated in the art of record[13], it is known that conventional ions are not suitable for surface processing of delicate semiconductors because of the undesirable sub-surface damage conventional ions can produce.

Applicant, thus, requests reconsideration and withdrawal of the rejections of claims 23-25, 27-28 and 31-33.

Rejection of Claims 1-22, 26, 29-30 and 34 under 35 USC §103(a)

Claims 1-22, 26, 29-30 and 34 were rejected under 35 USC §103(a) as being unpatentable over Kumar. More specifically, the Action asserts that Kumar teaches all the features of these claims except: (a) *at least one SAW device* as recited in claims 1, 3, 12 and 34;

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[10] Kumar, col. 10, ll. 26-30

[11] Kumar, Figs. 28B and 28C; col. 10, line 66 to col. 11, line 26

[12] Kumar, Abstract, line 1

[13] U.S Patent No. 5,459,326 to Yamada, referenced in Applicant's specification, par. 0012

(b) *a current collection device* as recited in claims 26 and 30; *a plurality of gases* as recited in claim 29. The Action further states that processing at least one SAW device, and using a current collection device and a plurality of gases are considered to be obvious design variations.

The Action cites instant Figures 1-2 as Applicant's admission that changing the properties of SAW devices is well known in the art. Reference in the instant specification to Applicant's GCIB production and use in processing SAW devices is clearly an error, evidenced by the rest of the application and the claims sought. Applicant's intent was only to show how a prior Art GCIB processor 100 might be used in the context of the novel SAW processing method recited in claim 1. The concept of using GCIB to etch or chemically react with one or more surfaces of one or more SAW devices in order to adjust their properties in either direction is novel and not taught or suggested by any art known to Applicant. No such anticipating or obviating art was specifically cited in the instant specification, and none could have been because, as evidenced by Applicant's instant claims, no such art exists.

As discussed above, Kumar discloses liquid metal cluster and conventional metal ion beams, both of which are completely distinct in manner of forming, composition and processing results from the GCIB recited in claim 1 and original claims 2-22 and new claims 35-38 which depend therefrom. Kumar's liquid metal cluster ion beam can be used to deposit metal on a surface and the conventional metal ion beam can be used to etch a surface, but not without causing unacceptable amounts of subsurface damage for a semiconductor device like a SAW device. The GCIB of the presently claimed invention enables etching or chemically reacting with surfaces of SAW devices to adjust their properties without such subsurface damage. As also indicated above, Kumar in fact teaches away from using liquid metal cluster beams for etching, instead recommending the use of conventional single-ion ion beams for etching.

As the patentability of claim 1 has been established over the art of record, Applicant respectfully requests reconsideration and withdrawal of this ground for rejection with respect to claim 1, and for original claims 2-22 and new claims 35-38, all of which depend from claim 1.

For at least the above noted reasons, Applicant respectfully submits that claims 1-38 are in a condition for allowance, and respectfully requests that the Examiner reconsider and withdraw all outstanding rejections. Favorable consideration and allowance are earnestly

solicited. Should there be any questions after reviewing this paper, the Examiner is invited to contact the undersigned at 617-854-4000.

Respectfully submitted,
JAMES A. GREER, Applicant

Dated: November 10, 2003 By: _____

Jerry Cohen
Reg. No. 20,522
Attorney for Applicant

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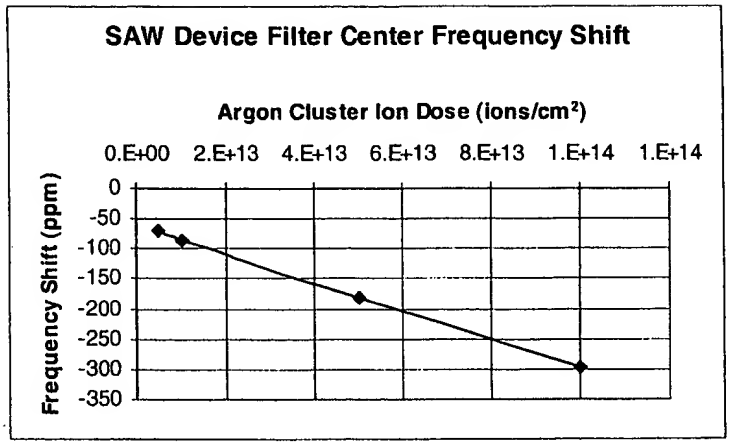

Figure 9A.

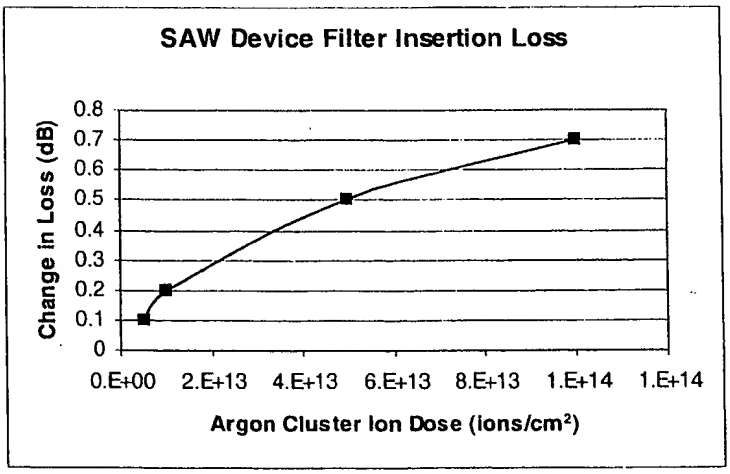

Figure 9B.